Human Action Recognition Based on Key Postures

A Thesis Submitted for the Degree of
Doctor of Philosophy

By

Yan Chen

in

School of Computing and Communications
UNIVERSITY OF TECHNOLOGY, SYDNEY
AUSTRALIA
SEPTEMBER 2009

UNIVERSITY OF TECHNOLOGY, SYDNEY
SCHOOL OF COMPUTING AND COMMUNICATIONS

The undersigned hereby certify that they have read this thesis entitled "**Human Action Recognition Based on Key Postures**" by **Yan Chen** and that in their opinions it is fully adequate, in scope and in quality, as a thesis for the degree of **Doctor of Philosophy**.

Dated: September 2009

Research Supervisor: _____

Xiangjian He

CERTIFICATE

Date: **September 2009**

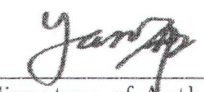
Author: **Yan Chen**

Title: **Human Action Recognition Based on Key Postures**

Degree: **Ph.D.**

I certify that this thesis has not already been submitted for any degree and is not being submitted as part of candidature for any other degree.

I also certify that the thesis has been written by me and that any help that I have received in preparing this thesis, and all sources used, have been acknowledged in this thesis.



Signature of Author

Acknowledgements

I would like to take this opportunity to express my sincere gratitude to my supervisor, A/Prof. Xiangjian He for his continuous encouragement, advice, help and invaluable suggestions. I feel really happy, comfortable and unconstrained with him during my PhD study here. Many thanks are also due to my co-supervisors, A/Prof. Tom Hintz and Dr. Qiang Wu for their valued suggestions and constant supports, and for the numerous conversations with them. I gratefully acknowledge the invaluable discussion with Prof. Massimo Piccardi.

I appreciate the financial assistance of Australian Postgraduate Award (APA) provided by the Australian government. I appreciate the travel support for attending the conferences which I received from the previous Faculty of Information Technology and the UTS Vice-Chancellor's Conference Fund. I also appreciate the financial support from a Student Equity Grant of UTS, which helped me release from housework.

I wish to thank my fellow research students and the staff of the school, especially those people listed below for providing various assistance for the completion of this research work.

- Wenjing Jia, Lihong Zheng, Huaifeng Zhang, Oscar Perez Concha, Hatice Gunes, Ahmed Otoom, Zui Zhang, Ruo Du, Cao Zeng .

Last but not least, I would like to thank my husband, Jianming, for his understanding and assistance. I also thank my parents and parents-in-law for their constant support. This thesis could not have been completed without the support and encouragement of my brother and my best friends.

To My Family, Felix and Ivan

Table of Contents

List of Tables

List of Figures

Author's Publications for the Ph.D

1. **Y. Chen**, Q. Wu, and X. He, "Human Action Recognition by Radon Transform," in book 'Multimedia Analysis, Processing and Communications', 2009, accepted.

2. **Y. Chen**, Q. Wu, and X. He, "Human Action Recognition by Radon Transform," in 2008 IEEE International Conference on Data Mining Workshops (ICDMW2008), pp.862-868, 2008.

3. **Y. Chen**, Q. Wu, and X. He, "Extracting Key Postures Using Radon Transform," in Image and Vision Computing New Zealand (IVCNZ08), IEEE Digital Library, 5 pages, 2008.

4. C. Du, Qiang.Wu., J. Yang, X. He, **Y. Chen**, "Subspace Analysis Methods Plus Motion History Image for Human Action Recognition", in Digital Image Computing: Techniques and Applications (DICTA2008), Canberra, Australia, pp. 606-611, December 2008.

5. **Y. Chen**, Q. Wu, X. He, W. Jia, and T. Hintz, "A Modified Mahalanobis Distance for Human Detection in Out-door Environments," in the First IEEE International Conference on Ubi-Media Computing, 2008, pp. 243-248.

6. **Y. Chen**, Q. Wu, X. He, C. Du, and J. Yang, "Extracting Key Postures in a Human Action Video Sequence," in the 10th International Workshop on Multimedia Signal Processing (MMSP2008), 2008, pp. 569-573.

7. **Y. Chen**, Q. Wu, and X. He, "Using Dynamic Programming to Match Human Behavior Sequences," in the 10th International Conference on Control, Automation, Robotics and Vision (ICARV2008) pp.1498-1503, 2008.

8. **Y. Chen**, Q. Wu, and X. He, "Motion Based Pedestrian Recognition," in IEEE Congress on Image and Signal Processing, 2008, pp. 376-380.

9. Y. Jiang, **Y. Chen**, Z. Zeng, and X. He, "A Bank Customer Credit Evaluation Based on the Decision Tree and the Simulated Annealing Algorithm," in the 8th IEEE International Conference on Computer and Information Technology, 2008, pp. 203-206.

10. X. He, J. Li, and **Y. Chen**, "Local Binary Patterns with Mahalanobis Distance Maps for Human Detection," in IEEE Congress on Image and Signal Processing, 2008, pp. 520-524.

11. **Y. Chen**, Q. Wu, X. He, W. Jia, and T. Hintz, "Pixel Structure Based on Hausdorff Distance for Human Detection in Out-door Environments," in Digital Image Computing: Techniques and Application (DICTA2007), pp. 67-72, 2007.

12. **Y. Chen**, Q. Wu, X. He, W. Jia, and T. Hintz, "Study on Human Behaviour Retrieval," in Proceeding of International Conference on Image Processing, Computer Vision, and Pattern Recognition, pp. 448-454, 2007.

Abstract

Human motion analysis has gained considerable interests in the computer vision area due to the large number of potential applications and its inherent complexity. Currently, human motion analysis is at an early stage. Its final aim is to generate an easy understanding, high level semantic description in a given scene. Human action recognition is an important step to the final aim of human motion analysis.

Human Detection

Human detection is part of the field of human motion analysis. The thesis looks at human detection. The thesis proposes a method using histogram of angles to discriminate pedestrians from vehicles. This proposed method is encouraged by the reality that humans are non-rigid objects. An angle formed by the centroid point and two bottom points for a human changes periodically while the angle for the vehicle is relatively static. In this part, this thesis also presents an approach to detect humans in static images. The thesis proposes an approach which uses human geometric features to fulfill the task.

Human Action Recognition

The thesis focuses on human action recognition. The thesis proposes what will be called a key postures based human action recognition approach. As we have known, human actions can be well described by a few important postures (called key postures) which are significantly different from each other and all other postures can be

clustered to these key postures. Therefore, these key postures can be used to represent and to infer the corresponding human action. The benefit of using key postures to represent human action is to reduce computational complexity. The thesis proposes two methods for human action recognition based on key postures. One is a human action recognition based on shape features and the other one is action recognition based on Radon transforms. Both methods follow three steps to achieve action recognition. These steps are video processing, key posture extraction and action recognition.

A two-step approach is proposed to extract key postures from preprocessed action video. These two steps are coarse selection and fine selection. Feature extraction and representation are discussed in both steps. After key postures are extracted from a video, key posture sequences are used to represent human actions. Each key posture sequence is regarded as an action template. In order to compare two action sequences, Dynamic Time Warping (DTW) is applied to determine the distance between the two action sequences.

In the second method, in order to obtain key postures, the action sequences are extracted from the preprocessed silhouettes using Radon transforms. Then, an unsupervised cluster analysis is applied to Radon transforms to identify the key postures for each sequence. Such key postures are used in the subsequent training and testing procedure. Several benchmark classifiers are used in this work for action learning and classification.

Author's Publications

This thesis covers the research results conducted by the author while undertaking for the degree. Most of the results have been published in research papers in refereed publications which are listed in Author's Publication for Doctor of Philosophy (PhD).